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EVOLUTION: OLD AND NEW.

Darwin and Modern Science. Essays in Commemoration of the Centenary of the Birth of Charles Darwin and of the Fiftieth Anniversary of the Publication of the "Origin of Species." Edited for the Cambridge Philosophical Society and the Syndics of the University Press by Prof. A. C. Seward, F.R.S. Pp. xvii+595. (Cambridge: University Press, 1909.) Price 18*s*. net.

IN bringing together the series of essays composing this volume, the Cambridge Philosophical Society, the syndics of the University Press, and the editor of the work, Prof. Seward, have rendered a public service for which all those who cultivate science in any of its numerous branches must be deeply grateful. It is an appropriate international memorial raised at a most opportune time in memory of the centenary of the birth of our greatest naturalist, and in celebration of the jubilee of the publication of that epoch-making book which made the principle of organic evolution a living reality in the strictest scientific sense. We have now been provided with a symposium of twenty-eight essays by English and foreign experts—every name being that of a recognised authority in that subject with which he deals. It is no exaggeration to speak of this work as monumental; it is a monument of greater durability than bronze or marble, because it stereotypes the collective thought of our age. For the future historian of science it must for all time serve as a land-mark indicating the present stage of development of scientific doctrine in every department of human thought where science holds sway, and where the great principle of evolution has, under Darwin's influence, served as a guide in the interpretation both of organic and inorganic nature.

It detracts in no way from the value of this volume that it is in the best sense "popular" as distinguished from technical. As stated in the preface, "Authors were asked to address themselves primarily to the educated layman rather than the expert." From this point of view some writers, as might have been expected, have succeeded better than others, although, on the whole, the result is highly satisfactory. The book should thus be particularly valuable to those workers in other departments of science or in other fields whose occupations have precluded their keeping pace with the rapid development in knowledge and mode of thought to which Darwin gave the impetus half a century ago. But it is difficult, if not impossible, to impose any restriction with respect to the class of reader to which these essays will appeal. The names of the authors whose services have been invoked will suffice to show that every branch of scientific culture has been influenced by the teaching of the man who in his modesty wrote of his own work shortly before his death:—

> "With such moderate abilities as I possess, it is truly surprising that I should have influenced to a considerable extent the belief of scientific men on some important points."

Biology naturally predominates, and for zoology and botany the names of Weismann, de Vries, Francis Darwin, Strasburger, Bateson, Sedgwick, Klebs, Loeb, Poulton, and Goebel stand as sponsors for their respective subjects. Schwalbe treats of the descent of man, and Ernst Haeckel of Darwin as an anthropologist. Geographical distribution is handled by Thiselton-Dyer and Hans Gadow; geology by Judd, and palæontology by W. B. Scott, of Princeton, and D. H. Scott. Lloyd Morgan writes on the "Mental Factors of Evolution," Höffding on evolution in relation to modern philosophy, Bouglé on sociology, the Rev. P. N. Waggett and Jane Ellen Harrison on the religious influence of Darwin's work. Philology is treated by P. Giles and history by J. B. Bury. For the essays on the application of the principle of evolution to inorganic nature we are indebted to Sir George Darwin, who treats of double stars, and to W. C. D. Whetham, who gives an account of the evolution of matter according to the modern hypothesis of atomic "disintegration." The history of evolution is written by J. A. Thomson, who treats of Darwin's predecessors, and by J. G. Frazer, who gives an account of early theories of the origin of man. An introductory letter from Sir Joseph Hooker appropriately prefaces this splendid contribution to the modern literature of evolution.

A work of the order and magnitude herein indicated does not come within the purview of the ordinary reviewer of scientific treatises. There is ample scope for discussion, for the views of some of the writers are at variance with those of others respecting the cardinal doctrine of the "Origin of Species by Means of Natural Selection," to quote the exact title of that classical work which the present volume commemorates. The one bond which unites all the contributors is the principle of evolution and the indebtedness of science, philosophy, and history to the man who made the nations "think in terms of evolution." Perhaps the best praise that can be bestowed upon the historical collection of essays forming the subject of this notice is to compare it in its candour with the writings of the master himself, for, as has so frequently been pointed out, the best and the severest critic of the theory of natural selection was Charles Darwin. It is only in harmony with the scientific spirit of our great leader that we should find between the same covers, and written with the same object of paying homage to the far-reaching influence of that leader's work, the strictly "selectionist" contributions of authors such as Weismann and Poulton, and the later divergent views of the schools represented by de Vries and Bateson. We quite agree with the latter that the greatness of Darwin's work is "that it may be admired from more aspects than one" (Essay v., p. 85). Perhaps not the least important of these aspects is that we must credit the "Origin" with having been the first work which successfully rescued the species question from the domain of ancient mysticism and ecclesiasticism, and handed it over to the scientific world for treatment by those same methods of investigation which had long been recognised as the only legitimate weapons of attack in other departments of natural knowledge—a true scientific emancipation of the whole group of natural sciences to which we now attach the label biology.

But even if the claim to our admiration be not based upon his application of the principle of natural selection, it must never be forgotten that for Darwin the conviction of the reality of this principle was the motive power of his life-work. The history of the revolutionary little volume which convulsed the world of science and shocked the outer laity in 1859 shows that, as the result of his observations and reflections during and after the voyage of the *Beagle*, he had become convinced of the mutability of species. But the mechanism of the process by which species were produced in nature was suggested to him, as it was subsequently to his compeer, Alfred Russel Wallace, by the writings of Malthus. From the time of his perusal of that work "for amusement" in 1838, his views began to take definite form. This is an oft-told story and hardly requires recapitulation, but at this momentous period it may be pertinent to point out that without this light from Malthus there would have been no Darwin-Wallace theory of the origin of species unless the illustrious founders of that theory had independently discovered the Malthusian principle. Whether the recognition of natural selection as "the main but not the exclusive means of modification" ("Origin," sixth edition, p. 421) is Darwin's chief claim to our homage is, as appears from the present essays, a matter of individual opinion. But whatever view be held now with respect to the function of natural selection, it was the predominant factor from the first to the last edition of the "Origin." It is not going too far to say that all his later work was prompted by this theory, which was, and is, a theory of "adaptations," as shown by his adoption of Herbert Spencer's paraphrase "survival of the fittest" for "preservation of favoured races." Happily for us of the present generation, Darwin resolved at the outset of his work to refrain from polemical discussion. His champions were numerous, and, like Huxley, masters of that art, and to them he left it to give battle to his opponents. The nearest approach to controversy to be found in his writings is the well-known chapter (vii. of the sixth edition) in the "Origin" in which he discusses a number of "miscellaneous objections" which had been urged against his theory. A re-perusal of that chapter at the present time will serve to show that *utility*—the "adaptational" value of the characters of organisms—was still the basic idea underlying his replies to his critics.

A collection of essays such as those which make up the present volume would require, not a single reviewer, but a staff of reviewers to do justice to their contents. It would be impossible to give anything approaching an adequate account of the treatment of the various subjects by their respective authors within the limits of an ordinary press notice, even in the columns of a scientific journal. Some of the essays are quite easy to follow; others are necessarily more or less technical. In the way of absolute novelty there is not much to be found, nor, indeed, could novelty be expected from writers dealing with subjects which have in one form or another been before the scientific world for many years. The novelty is to be found rather in the way in which each contributor presents his case—in the consensus of homage paid to Darwin's influence in each particular field. If it is not invidious to make a selection, Judd's chapter on "Darwin and Geology" (xviii., p. 337) is the most fascinatingly interesting from the historical point of view. Weismann's, Poulton's, and D. H. Scott's contributions will be found delightful reading by those who (like the present writer) still believe that the Darwinian theory is a theory of adaptations. Poulton, by the way, gives us more novelty than any other writer by inserting some hitherto unpublished letters of Darwin, and by printing extracts from Burchell's note-books bearing on mimicry and protective resemblance. It is in no captious spirit that the essay of de Vries is referred to as lacking in lucidity; his statement of Darwin's position (p. 67) might have been made clearer, and the presentation of his own views—whether they are accepted or not—scarcely does justice to their distinguished author. Haeckel's contribution still rings with the battle-cry of the victor over his defeated German anthropological opponents. Those who look to the work as an authoritative expression of evolutionary opinion must perforce be struck by the omission of certain names which we should have liked to see on the list of contributors. The names of Alfred Russel Wallace and Francis Galton are conspicuous by their absence. Biologists would no doubt have been glad also to read essays by Henry F. Osborn, of Columbia University, by Sir Ray Lankester, and by Karl Pearson. "Biometricians" are not represented. Presumably there are valid reasons for these omissions, but the loss is ours nevertheless. The hypercritical reader also may want to know what influence can have been exerted by Darwin's work upon the genesis of double stars (Sir George Darwin, Essay xxviii., p. 543), or upon the evolution of matter as expounded by Mr. Whetham (Essay xxix., p. 565). Speculations on the "transmutation" of matter are older than any theories of the transmutation of species. But both these subjects now fall as naturally into the general scheme of evolution as do any of the cosmical theories admitted by Herbert Spencer in the "First Principles," and are, therefore, quite appropriate in the present volume. The only regret that can be expressed is that more space has not been given to inorganic evolution. We should have profited much by a popular exposition both of Sir Norman Lockyer's views on stellar evolution and of Sir George Darwin's suggestive application of the principle of survival among elementary atoms in his address to the British Association in 1905.

Now, bearing in mind the *raison d'être* of the work under consideration, the "resting stage," to use a biological expression, in the history of Darwinism provided by this galaxy of expert opinion enables us to formulate certain very definite questions. What has the "educated layman" to believe now with respect to Darwin's cardinal doctrine after the lapse of half a century? Has the theory that species *originate* mainly but not exclusively by natural selection stood the test of time; has it been modified in any material particulars since Darwin's days, and, if so, in what direction and to what extent? Out of the conflicting views on this fundamental point it is safe to extract the general conclusion that for the great majority of living biologists natural selection is still a working power in organic evolution. Equally evident must it be to those who weigh the evidence brought together in these essays that the theory, as bequeathed to us by its illustrious founder, has, to borrow certain photographic terms, undergone in some directions intensification and in other directions reduction. By way of intensification we have the elimination of the effects of "use and disuse" and of "direct action" of the environment—the deletion by Weismann of all the Lamarckian factors. It is sufficiently notorious that Darwin attached a certain weight to these factors. When, in 1862, Hooker was inclined to throw over "direct effects of conditions," he wrote:—

> "It is really curiously satisfactory to me to see so able a man as Bates (and yourself) believing more fully in natural selection than I think I even do myself" ("More Letters," vol. i., p. 199).

The same point is well brought out by Schwalbe in the present volume (p. 125), and by Haeckel (p. 141), although it may well be doubted whether Darwin was so much of a Lamarckian as Haeckel would make out. But in accepting the Lamarckian factors as subsidiary aids in the development of species, it must not be forgotten, as has so frequently been pointed out, that Darwin was only expressing the current belief of the time. The efficiency of these factors in producing individual modifications was an observed fact, but their inheritance was an assumption. The validity of this assumption was not challenged by Weismann until after Darwin's death, and the master, to our everlasting regret, never had an opportunity of weighing the evidence brought against these factors which he regarded as subsidiary. If it is permissible to speculate as to the probable effect of Weismann's contention upon Darwin's "immortal work" (Schwalbe, p. 125) and "epoch-making" volume (Haeckel, p. 143), it may, perhaps, be admitted that "the 'Origin' without 'use and disuse' would be a materially different book" (Bateson, p. 89). But in what way different? It may very well have transpired that the views of its great author would have become more rigidly "selectionist," as did those of Wallace after he had considered and admitted the cogency of the arguments against the Lamarckian tenets.

In view of the state of knowledge concerning heredity at the time of the publication of the "Origin," it may fairly be asked whether it is so absurdly unscientific, as many opponents of natural selection used to tell us, to extend the views of the founder of a great principle beyond the limits foreseen by their founder. The history of science furnishes numerous examples of such developments. We never heard it urged in scornful argument, for example, against the electro-magnetic theory of light that Clerk-Maxwell had made himself ridiculous by becoming more of an "undulationist" than Young and Fresnel. If, departing from Haeckel, who agrees with Herbert Spencer in rejecting Weismann's views (p. 140), we follow Francis Galton, Wallace, Poulton, Bateson (presumably, p. 89), and those who agree in believing that Lamarckism is discredited, we strike out a factor in species formation which "aided [natural selection] in an important manner" ("Origin," sixth edition, p. 421). The importance of natural selection *may*—it does not logically follow that it *must*—thereby be enhanced. It is perfectly scientific, and quite in harmony with the spirit of the great leader whose mind was ever open to fresh evidence, to believe that not only has natural selection stood the test of time, but that its author may have under-estimated rather than exaggerated its importance. This is the direction in which the theory has undergone intensification.

In the opposite direction and by way of reduction we have a number of opinions which practically amount to traversing Darwin's claim for natural selection as the "main" factor. Some attach less importance to it, some give it quite a subordinate *rôle* and a few almost appear to imply that it can be dispensed with altogether:—

> "The discovery of de Vries that new species may arise by mutation and the wide if not universal applicability of Mendel's law to phenomena of heredity, as shown especially by Bateson and his pupils, must for the time being, if not permanently, serve as a basis for theories of evolution" (Loeb, p. 269).

Perhaps the author of the above passage will not admit that it bears this construction, but at any rate, as an example of the reducing action exerted by a certain class of modern workers, it seemed typical. Darwin thought that he had given a working theory which, if it did not completely solve, at least went a very long way towards solving the problem of the origin of species in nature. Bateson tells us (p 99):—

> "The time is not ripe for the discussion of the origin of species. With faith in evolution unshaken—if indeed the word faith can be used in application to that which is certain—we look on the manner and causation of adapted differentiation as still wholly mysterious."

The "educated layman"—if his sense of humour has not been educated out of him—may possibly want to know why, if the species question is to be thus thrown into the melting-pot, the Cambridge authorities thought it advisable to issue a volume to commemorate "the fiftieth anniversary of the publication of the 'Origin of Species.'" It is, of course, perfectly legitimate for any biologist who has considered the question to declare that he is dissatisfied with the evidence on which Darwin based his claim for the prepotency of natural selection—to bring in a verdict of "not proven." That is a matter of individual judgment on the evidence submitted. But in giving this verdict, it must be clearly recognised that he is taking a position diametrically opposed to that of the author of the book which is being commemorated. It may be said, and is virtually said by some of the contributors, that the claim to the commemoration of the "Origin" is not based upon the discovery of the principle of natural selection, but is due to the circumstance that that work brought conviction to naturalists as well as to the educated public of the truth of evolution as a principle. It unquestionably did so, but since the assertion has been made that without Lamarckism the "Origin" would have been a different work, it may be permissible to raise the question whether, without natural selection, the mere marshalling of the facts of evolution—even by the master mind of Darwin—would have done more towards establishing that principle than did the writings of the pre-Darwinian evolutionists or the powerful advocacy of Herbert Spencer before the publication of Darwin's work. At any rate, the discovery of natural selection was the cause of the publication of the "Origin," and the success of that book is attributable to the theory—the working mechanism of species formation which, rightly or wrongly, it proclaimed.

Not the least valuable feature of this volume of essays is that, by bringing together the views of the different and often antagonistic writers, it enables the ordinary reader to get a clear notion of the various lines of divergence from Darwin's original position. The representatives of the modern school of "genetics," for example, base their homage on the fact that he introduced scientific method into the study of variation and heredity:—

> "Evolution is a process of variation and heredity. The older writers, though they had some vague idea that it must be so, did not study variation and heredity. Darwin did, and so begat not a theory, but a science" (Bateson, p. 88).

Perfectly true so far as it goes; but his study of variation and heredity was prompted from beginning to end by his desire to find out how the raw materials were supplied by nature for the action of natural selection (see the introduction to "Variation of Animals and Plants," *passim*). Also it is now a matter of history that Darwin's work in this very line of study did beget a theory—the "provisional hypothesis of Pangenesis," of which Strasburger says (p. 111):—

> "We can however affirm that Charles Darwin's idea that invisible gemmules are the carriers of hereditary characters and that they multiply by division has been removed from the position of a provisional hypothesis to that of a well-founded theory. It is supported by histology, and the results of experimental work in heredity, which are now assuming extraordinary prominence, are in close agreement with it."

There can be no reasonable doubt in the minds of those who are familiar with Darwin's books that his study of variation and heredity centred round his main theory of natural selection, and the first question that the "educated layman" may well ask in this connection is, How far has our knowledge been extended since Darwin's time? It does not appear from the present body of evidence that we have got very much beyond Darwin with respect to the causes of variation in nature. Some ingenious hypotheses have been suggested, and varieties have been classified and put into named categories, but that is all. With respect to heredity it is generally conceded that *when certain varieties appear* the laws which determine their transmission are now, thanks to the experiments of Mendel and those who are continuing his work, being definitely established. This is undoubtedly a most important line of investigation, and evolutionists will anxiously await further developments. In the meantime, however, it would appear that at the halting period marked by this present volume, the experiments on cross-breeding have not yet contributed anything constructively to the main problem which Darwin set out to solve, since we have it on the authority of the leader in this class of work that "the time is not ripe for the discussion of the origin of species."

With respect to another divergence since Darwin's time, viz. the mutation theory of de Vries, readers must be referred to the author's own account (Essay iv., p. 66). Want of space forbids an analysis of this later departure in the way of "saltatory evolution," only it must be noted that this kind of variation was considered by Darwin over and over again, and always with the conclusion that it played no important part in the formation of species in nature. It will be noted also that de Vries still subordinates his "mutations" to the action of natural selection, and to this extent is a follower of Darwin. Although the bearing of this aspect of variation upon Darwin's theory has been discussed by many able writers, it may be useful at this period to direct attention to the fact that it is unhesitatingly rejected by Haeckel as giving no explanation of adaptations and as having "no causal value" (p. 141). Here is what Darwin wrote on this point in the last edition of the "Origin":—

> "Mr. Mivart is further inclined to believe, and some naturalists agree with him, that new species manifest themselves 'with suddenness and by modifications appearing at once.' . . . This conclusion, which implies great breaks or discontinuity in the series, appears to me improbable in the highest degree" (p. 201).
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> "Although very many species have almost certainly been produced by steps not greater than those separating fine varieties; yet it may be maintained that some have been developed in a different and abrupt manner. Such an admission, however, ought not to be made without strong evidence being assigned" (p. 203).

Whether the evidence offered on behalf of this divergence from the "Origin" is sufficiently strong to warrant its adoption is still an open question (see Poulton's "Essays on Evolution," introduction, p. xiv). It is true that the author of modern "mutationism" is inclined to believe that Darwin recognised two kinds of variation, ordinary fluctuations and those which "happen to arise" ("Origin," sixth edition, p. 169), but those who have really mastered Darwin's meaning will agree with Prof. Seward's and Mr. Francis Darwin's contention (p. 71, footnote, of present work) that this interpretation of the passage in the "Origin" is incorrect. This, by the way, is the only "editorial" comment to be found in the volume under consideration.

Now, if we ask ourselves what has been the net result of the publication of the "Origin of Species" on the main question with which it deals, or, in other words, How stands the species question after passing the ordeal of half a century? the answer must be that the only theory of species formation which still holds the field is that theory of natural selection which suggested itself to Darwin after reading Malthus in 1838, and independently to Wallace in 1858. Before 1838 it may be said that Darwin was a convinced evolutionist; subsequently he became a selectionist. Whether the reader of the present collection of essays takes the view that time has acted as an intensifying or a reducing agent upon the validity of the fundamental doctrine enshrined in that work which is now being commemorated, it is perfectly clear that the historian who in the distant future—say at the next Darwin jubilee—consults the present book in order to ascertain what platform had been reached in the year 1909 cannot but arrive at the conclusion that at the time of the publication of this memorial volume no alternative theory of the origin of species had survived the test of scientific criticism. No more effective mechanism of organic evolution than that offered to us by Darwin fifty years ago has up to the present time been suggested. We may degrade natural selection from the position assigned to it by Darwin, or the still higher position assigned to it by Wallace and Weismann as the result of post-Darwinian discovery; we may attach quite a small value to it as a factor, or we may eliminate it altogether. If so, the other factors remain to be discovered, and we must declare that we are still without a theory of the origin of species. The effects, direct or indirect, of the publication of the "Origin" upon lines of thought and of work other than those centring round the main question of species are sufficiently well known; the present volume bears living testimony to their far-reaching importance.

There is one other aspect of Darwin's work which at this juncture it may be opportune to insist upon. There is much talk in our time about "scientific method," "scientific habit of thought," and so forth; and yet it seems that there is a tendency among our present workers to neglect the example set by the great master, whose memory will ever be upheld with undiminished reverence by those who had the privilege of knowing him personally. It is he who, above any scientific worker of his time, taught us the value of *cumulative evidence* in establishing a new theory. Of his own doctrine he wrote:—

> "Now this hypothesis may be tested—and this seems to me the only fair and legitimate manner of considering the whole question—by trying whether it explains several large and independent classes of facts" ("Variation of Animals and Plants," first edition, 1868, p. 9).

Is that canon faithfully followed now? We fear not. With many workers, one or a few observations, or the taking of a few measurements, combined with the complete exclusion of "independent classes of facts," suffice to provide a new theory of the universe. The lesson conveyed by the revolution in scientific thought effected in a comparatively short period by one book is in danger of being overlooked by the present generation.

R. MELDOLA.

PROF. FISCHER'S INVESTIGATIONS ON THE CARBOHYDRATES AND ON FERMENTS.

Untersuchungen über Kohlenhydrate und Fermente (1884–1908). By Emil Fischer. Pp. viii+912. (Berlin: Julius Springer, 1909.) Price 22 marks.

PROF. EMIL FISCHER continues to put all chemists under an obligation to him by the re-publication, in collected form, of the series of remarkable investigations by which he has made the present Berlin school of chemistry famous for all time. These contributions to chemical literature are absolutely unique; in extent, in character, in originality and completeness, they are unparalleled. Not even Liebig, in his most forceful and prolific period, showed himself more able as a leader, more fruitful in directive ability, or more inspiring as a central controlling figure, than the present head of the most celebrated chemical laboratory of the world. The volume before us follows in quick succession that on the amino-acids, polypeptides, and proteins (1899–1906), and that on the investigations in the purin group (1882–1906). Collectively, these works constitute a monument more enduring than brass, and mark an epoch in the development of the science.

In a sense, Emil Fischer is the Paracelsus of his period—not, we hasten to add, in his mental habitudes or in his methods of inculcating his doctrines, but as the exponent and representative of a new phase in the evolution of chemical thought. What Paracelsus and van Helmont were to iatro-chemistry, Pasteur and Fischer are to bio-chemistry. But the analogy is only partial, and, indeed, soon breaks down. The truculent, turbulent Schweizer added ideas to science, but no new facts; the bland and suave Berliner, distinguished in manner and courteous in bearing, has enriched his science with innumerable facts and illumined it with ideas as the logical outcome of the facts. Other times, other manners. Nothing is more reassuring than to compare the "Opera Paracelsi," as turned out by Operinus, with the "Opera Fischeri" as published by the house of Julius Springer. Four hundred years have certainly done something for human civilisation. We may at least lay that unction to our souls.

The main significance of Fischer's work is in its relation to physiology. That physiology and chemistry are intimately connected and mutually related goes without saying; the fact has been recognised from the earliest times—certainly from the period of Galen and Avicenna. But it is Fischer's great merit that, after a comparatively arid and sterile period in physiological chemistry, due largely to the circumstance that the time and energy of the leaders of organic chemistry were directed to the exploration of other regions, he should have turned the force of his genius to the elucidation of the constitution of those substances which are dependent upon, or obviously connected with, vital processes. The sugars and the starches were among the earliest known of so-called organic compounds. They have long been recognised as among the most characteristic products of the physiological activities of plants, and from time immemorial they have been regarded as among the